Hatch Mott MacDonald

Parallel Runway Design and Construction at Cancún International Airport, Mexico

George Nowak, P.Eng.

SWIFT Conference, Montreal

September 17, 2015

Presentation Outline

- Cancún and New Runway Geometry
- Runway Elevation and Drainage Criteria
- Surface and Subsurface Conditions
- Runway Subgrade (Cenote) Repair
- Runway Pavement Design
- Embankment Fill and Construction
- Runway Construction and Completion Photos

Hatch Mott MacDonald

Cancún and New Runway Geometry

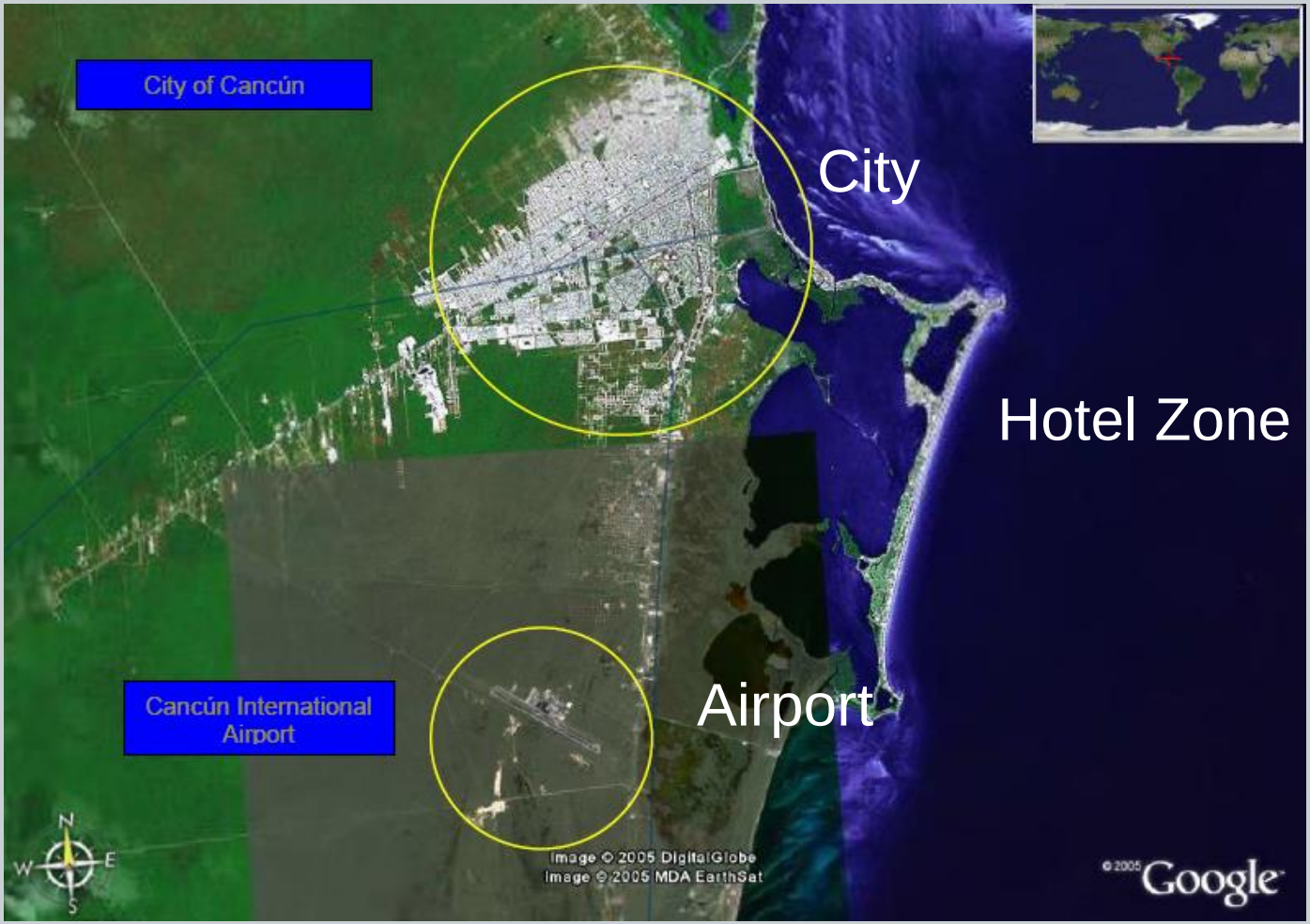
Hatch Mott MacDonald

CUN:

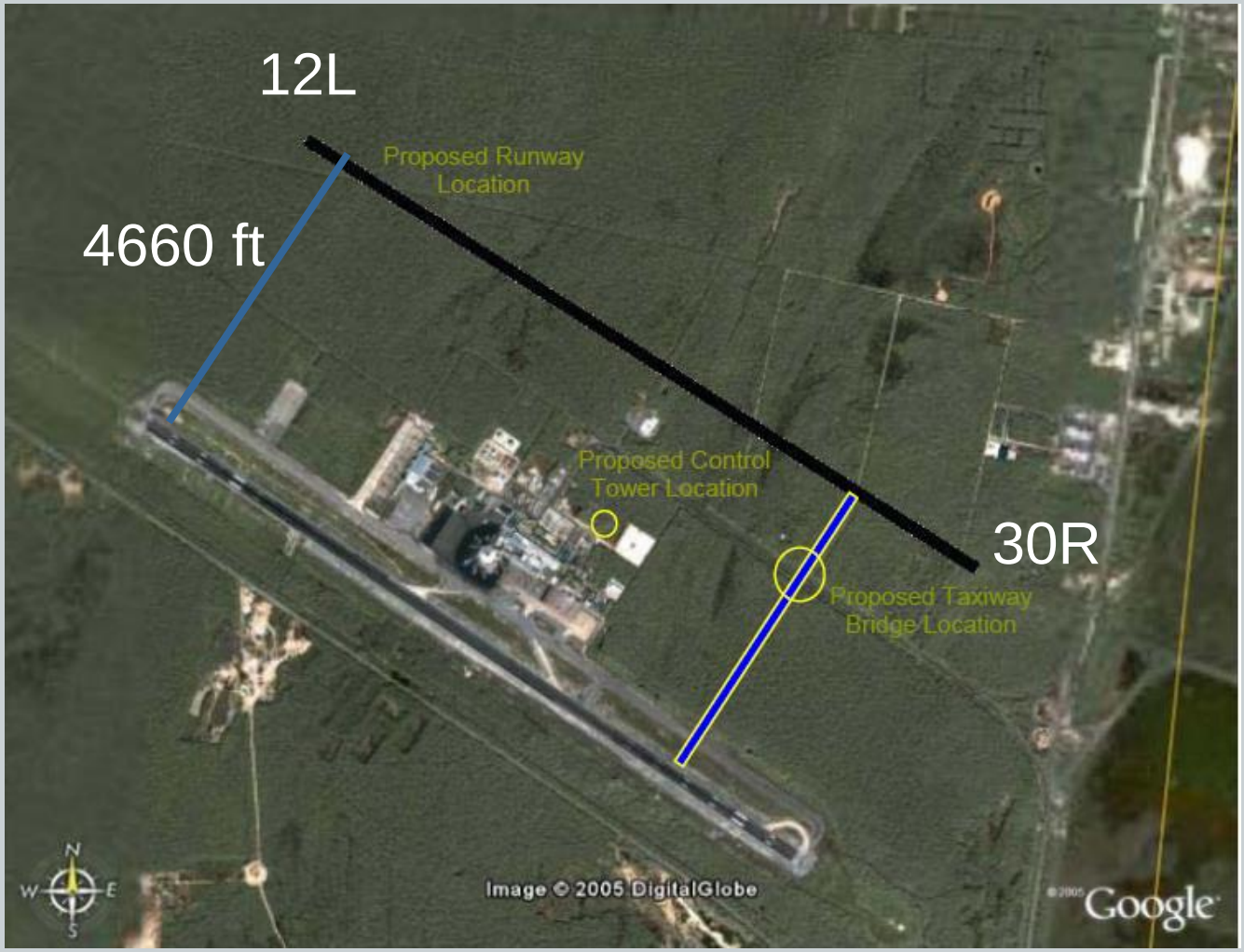
Over 18 million Pax
Projected in 2015
15% Annual Growth

City: 700,000+

Cancún and Airport Location



New Runway 12L-30R and X-over Twy

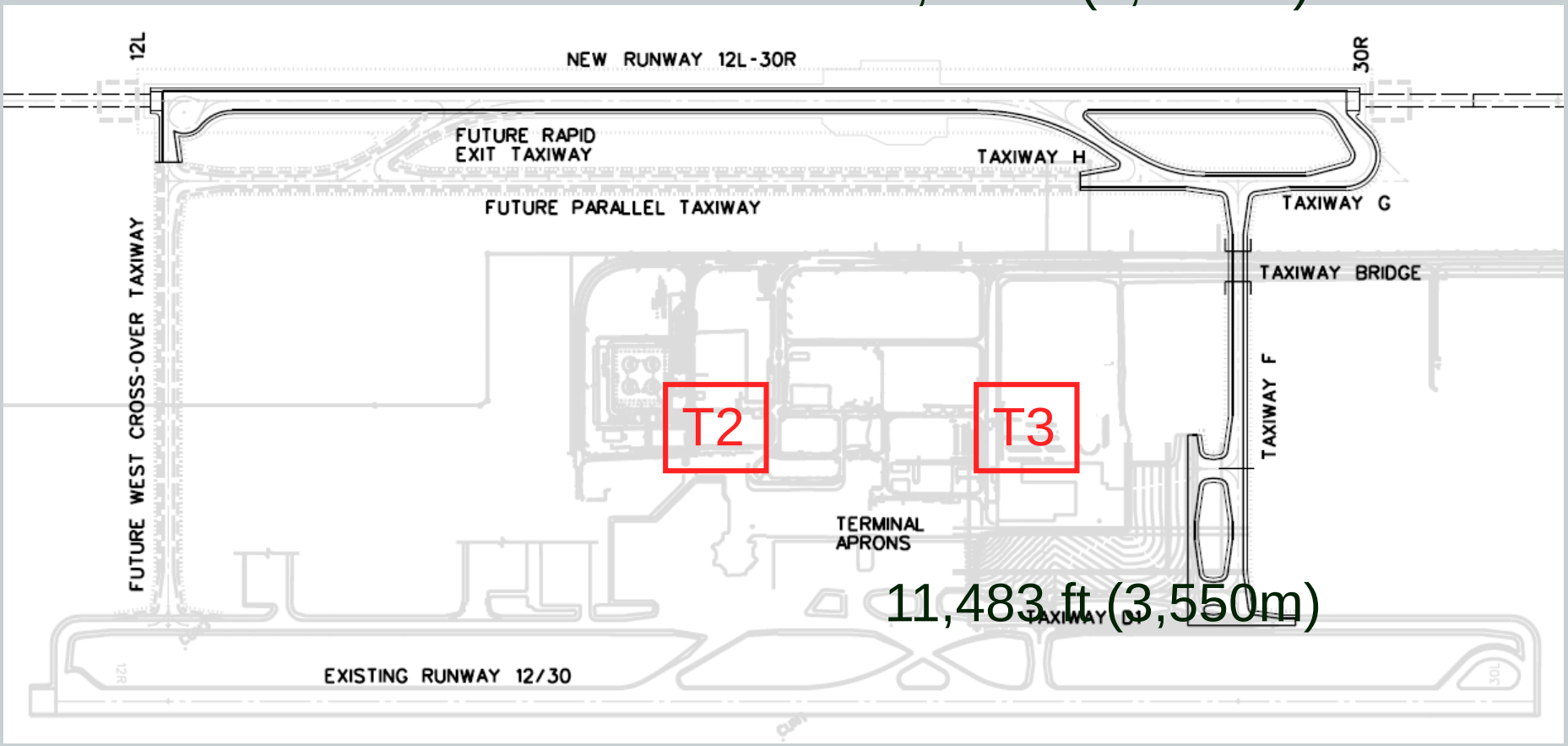


Hatch Mott MacDonald

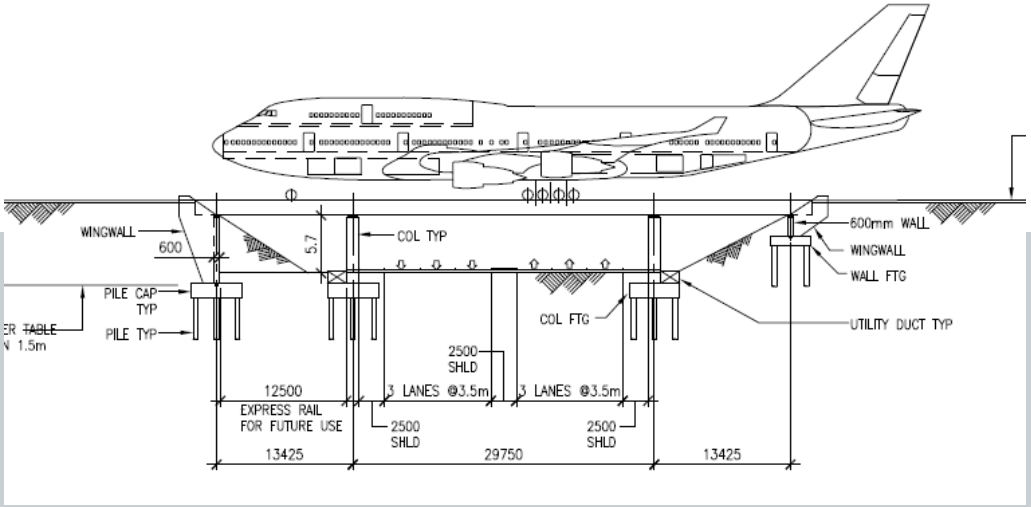
Runway Length Analysis : 9200ft (2800m)

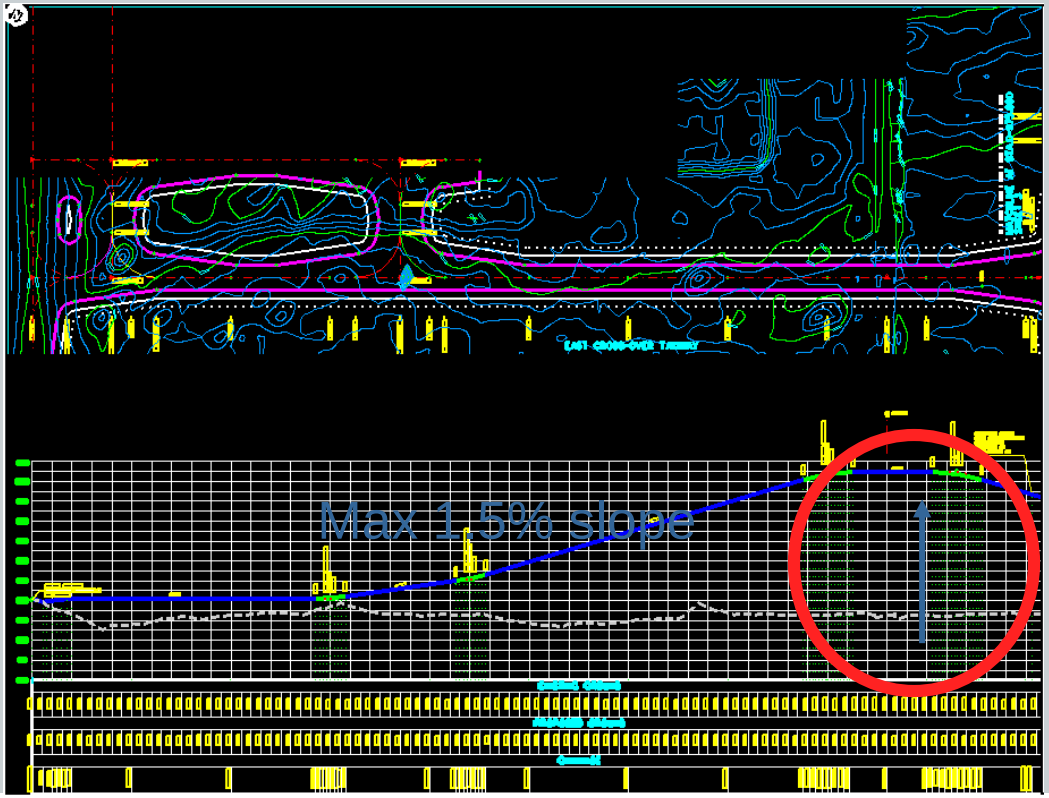
New Runway Geometry
- ICAO Aerodrome Standards (DGAC Mexico)

9,186 ft (2,800 m)



Hatch Mott MacDonald





Taxiway F Bridge

23 ft (7 m) fill

Hatch Mott MacDonald

Runway Elevation and Drainage Criteria

Design Storm / Runway Design Elevation

- Wilma - Category 5
- Mexico hit on Oct. 21, 2005
- Sat in Cancún area - 3 Days @ 3 km/hr
- 24-63” (600-1600 mm) rainfall
- Design Elevation of 4.26m ASL – no flooding on existing runway
- Ground elevation varies from 1.2 to 5.8 m ASL in runway area

Runway/Taxiway Drainage Design →

- No Stormwater Piping except to drain confined pavement areas
- No Ditches – water table usually at +0.5m to +1.0m ASL
- Cancún Aquifer provides drinking water to surrounding areas and City
- Drainage (infiltration) Wells drain into Cancun Aquifer – need more drainage?- then add some more wells
- Drainage wells typically 30m deep with infiltration rates about 285 gallons/min (18 liters/sec)

Hatch Mott MacDonald

Surface and Subsurface Conditions

Hatch Mott MacDonald

Clearing and Residual Topsoil

Hatch Mott MacDonald

Runway Strip After Clearing

Geotechnical Profile

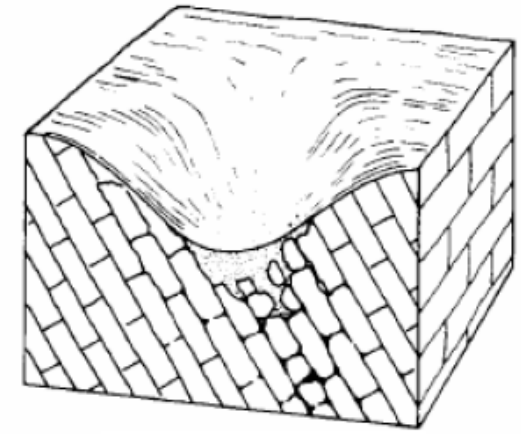
- Airport Geology
  - Limestone coral Basement Rock (>1200m)
  - Karst Development (Sinkholes = “Cenotes”)
  - Deposits of weathered limestone/coral (Locally called “Sascab”)
  - Limited Topsoil and Fill

Hatch Mott MacDonald

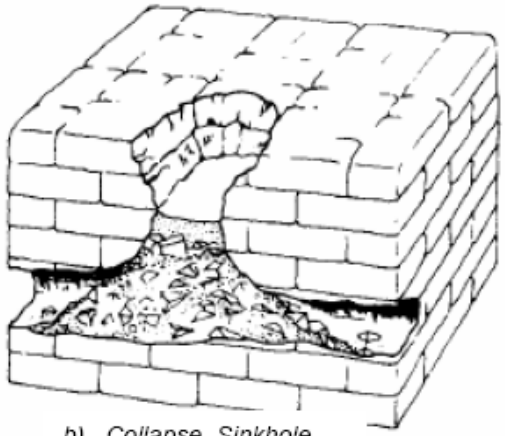
Typical Rock Core

Sinkholes (Cenotes)

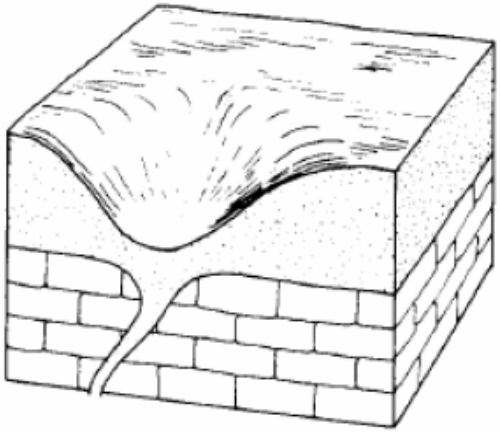
The four primary sinkhole mechanisms to be found in the area of Cancún include the following:



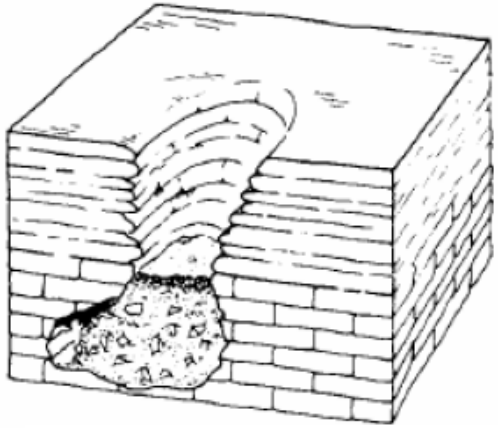
a) Solution Sinkhole



b) Collapse Sinkhole



c) Subsidence Sinkhole



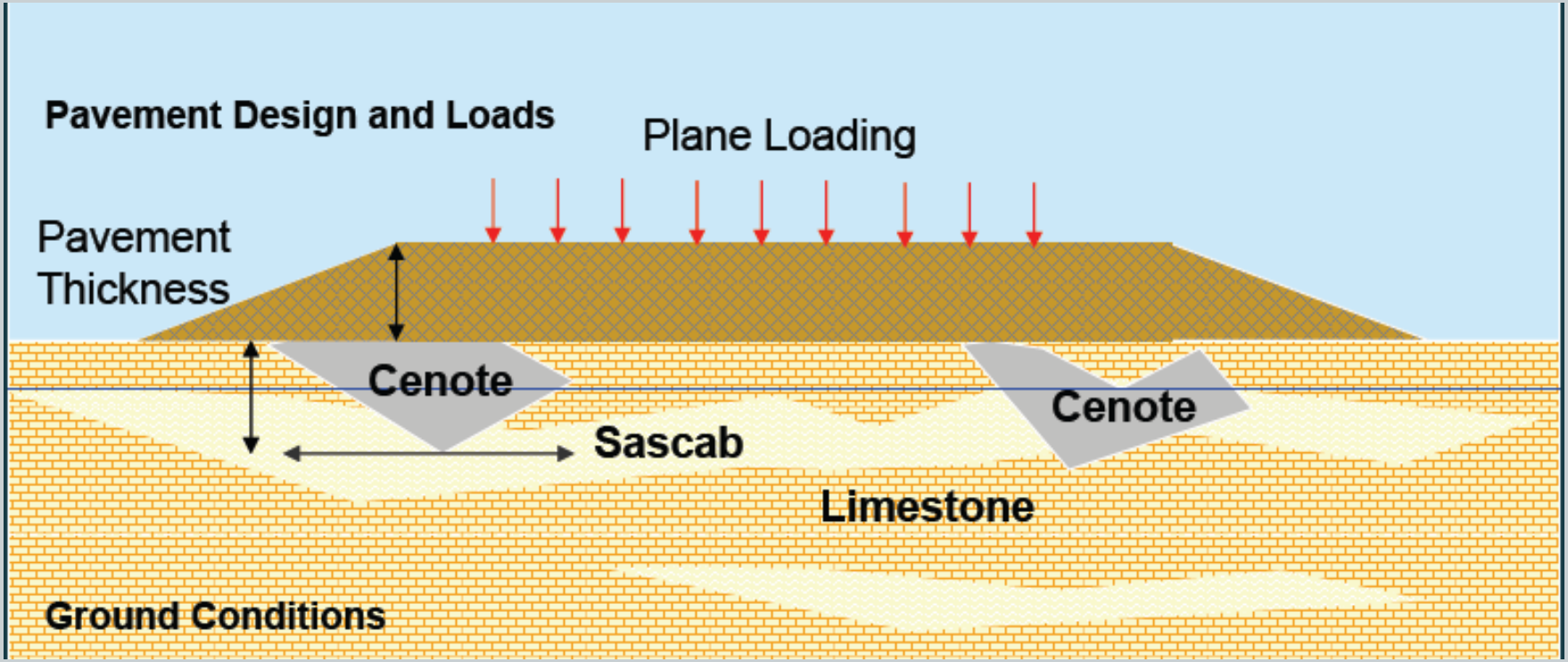
d) Subjacent Karst Collapse Sinkhole

Cenote Mapping and Repair

- Three Basic Types
  - Open Basin
  - Deeper Cavern
  - Hidden
- Mapping Done by Client after clearing and topsoil removal – 134 found in Runway and Taxiway Areas
- Repair Techniques by Client – perfected during Terminal 3 apron construction

Hatch Mott MacDonald

Risk Assessment



Hatch Mott MacDonald

Largest Basin Cenote – 43 ft. (13m) dia.

Hatch Mott MacDonald

Cavern Type Cenote in Rwy Area

Hatch Mott MacDonald

Hidden Cenotes – How Big?

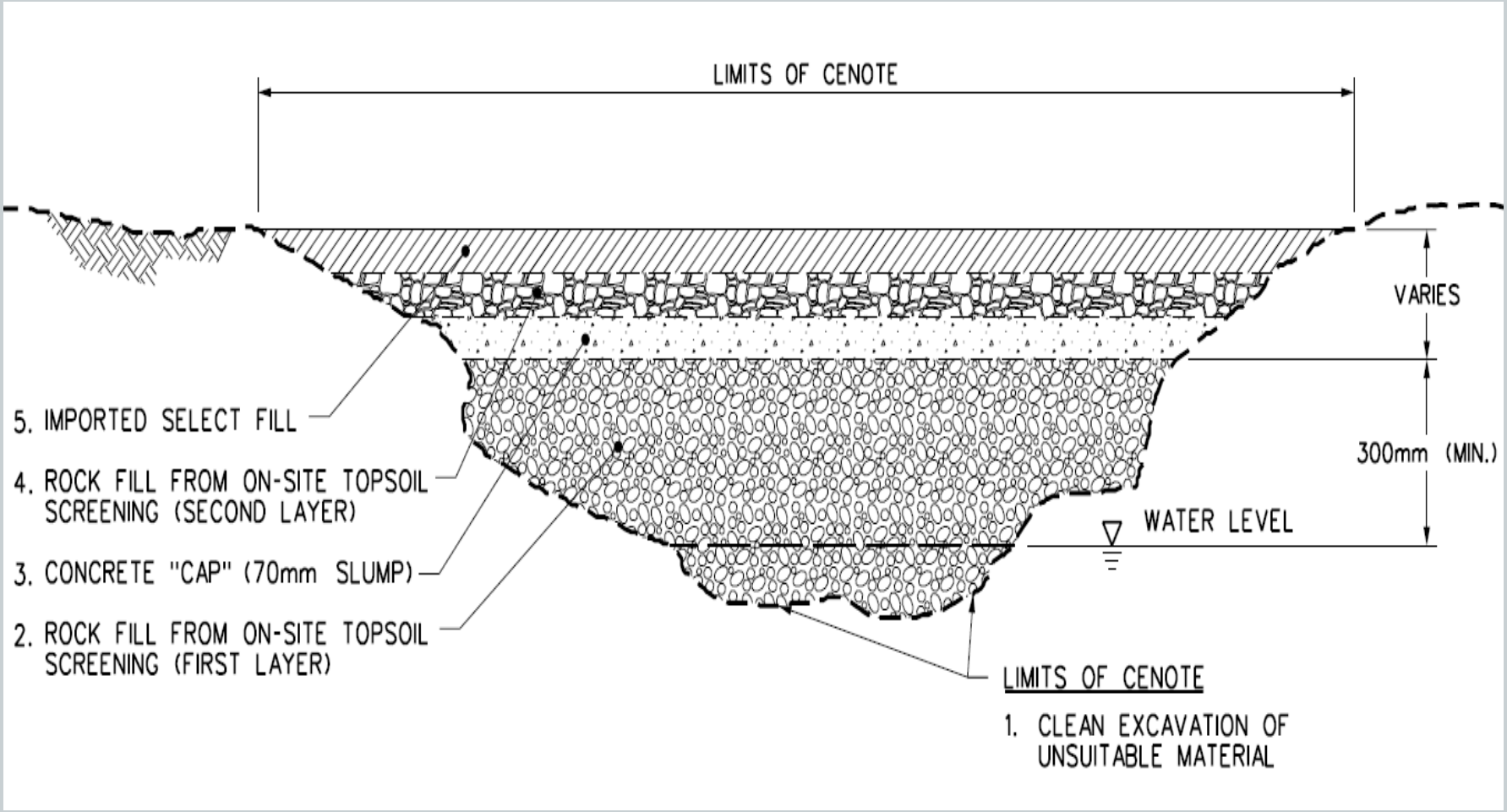
Hatch Mott MacDonald

Drill perimeter to delineate and excavate – achieving one metre rock face depth →

Hatch Mott MacDonald

Runway Subgrade (Cenote) Repair

Typical Cenote Repair Technique



Hatch Mott MacDonald

Cenote manual cleaning

Lean concrete to seal rock fill and cenote perimeter water channels

Hatch Mott MacDonald

Cenote Backfill to Subgrade Level

What about the "Unmapped" Cenotes?

- How to find hidden caverns with NO surface indication?
- Tried geophysics (electrical resistivity) on T3 apron – very poor correlation.

Proofrolling with 50 Ton 4-Wheel Roller

Runway Subgrade after Cenote Repairs

Hatch Mott MacDonald

Pavement and Embankment Design

Pavement Design

- Flexible Design only considered as per contract (existing runway is flexible)
- Compared FAA (LEDFAA 1.3) and FAARFIELD(beta version at the time) and Transport Canada methods
- 24 pavement sections considered in analysis (variations on arr/dep traffic and minimum thicknesses)
- Use T3 apron “Sascab” k and CBR values (lowest CBR is 35+ and plate load tests show conservative k of 87 MN/m^3 (320 pci))
- Note: Software does not accept more than 30 for CBR Subgrade input

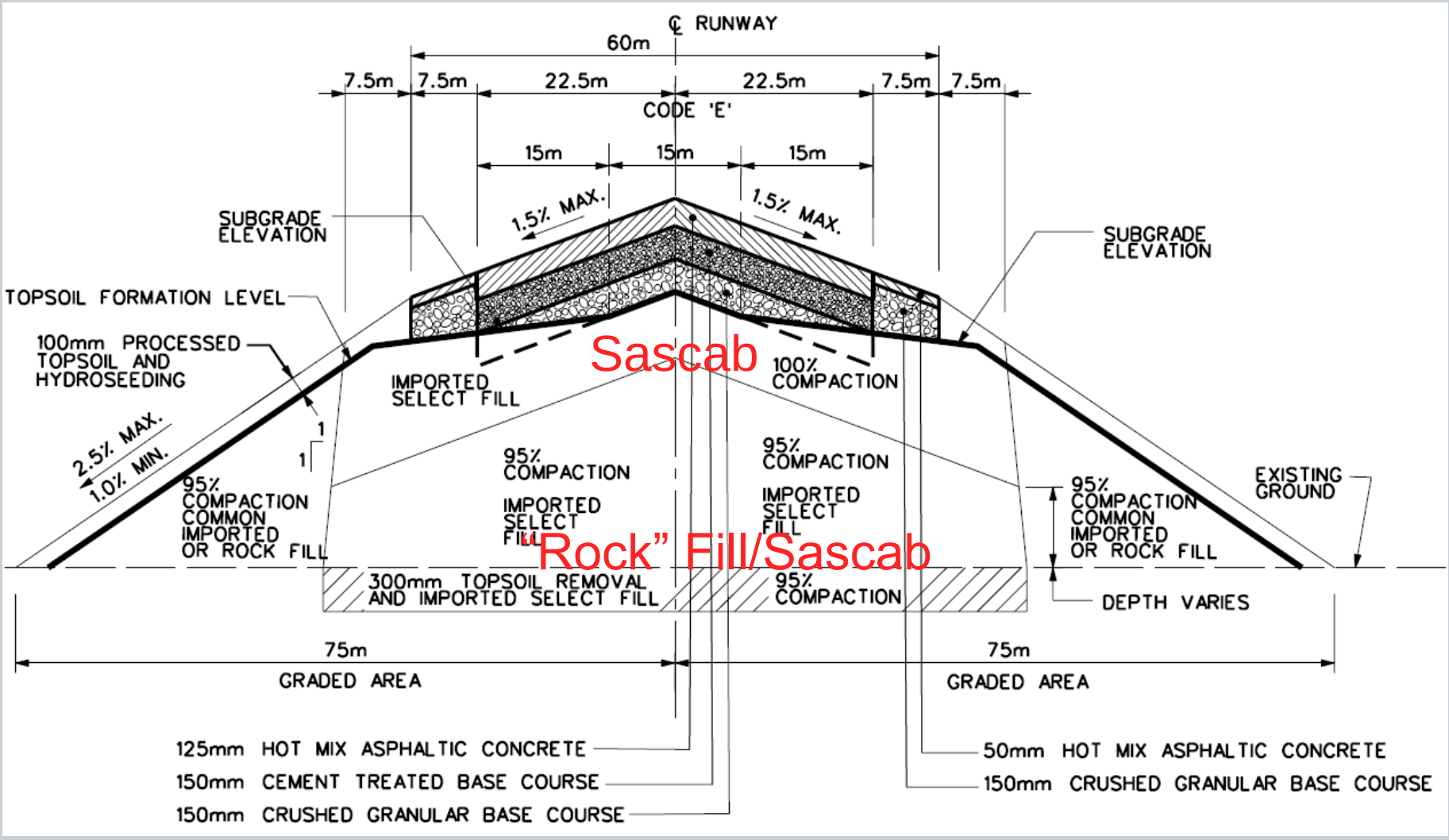
Runway/Taxiway Pavement Layers →

- 5” (125 mm) HMA
- 6” (150 mm) CTB (4” calculated)
- 6” (150 mm) Crushed Granular Base (4” calculated)
- 100% Modified Proctor Compaction 40” (1000 mm) below finished surface
- 95% Modified Proctor Compaction below 40”
- Subgrade Formation CBR 35% (28.5% used)
- Expected service life 40 years on structure (CDF) = remaining 40 years of 50 year concession.

Runway/Taxiway Earthwork Quantities

- "Fill" project – 95% Fill/ 5% Cut based on design elevation/drainage criteria
- Imported "rock" and "Sascab" fill from local quarries
- Approximately 1.4 million C.Y. earthworks

Typical Runway Fill Section



Hatch Mott MacDonald

Embankment Fill Properties and Construction (Sascab and Rockfill)

Hatch Mott MacDonald

What is “Sascab”?

- Decomposed limestone (from freshwater migration and deposition of fine $CaCO_3$)
- Light brown silty sand or sandy silt and gravel that is highly cementitious in its natural state
- Used historically by Mayans (200-900 AD) as mortar and now as building and paving material (engineered fill) due to cementitious properties when re-compacted

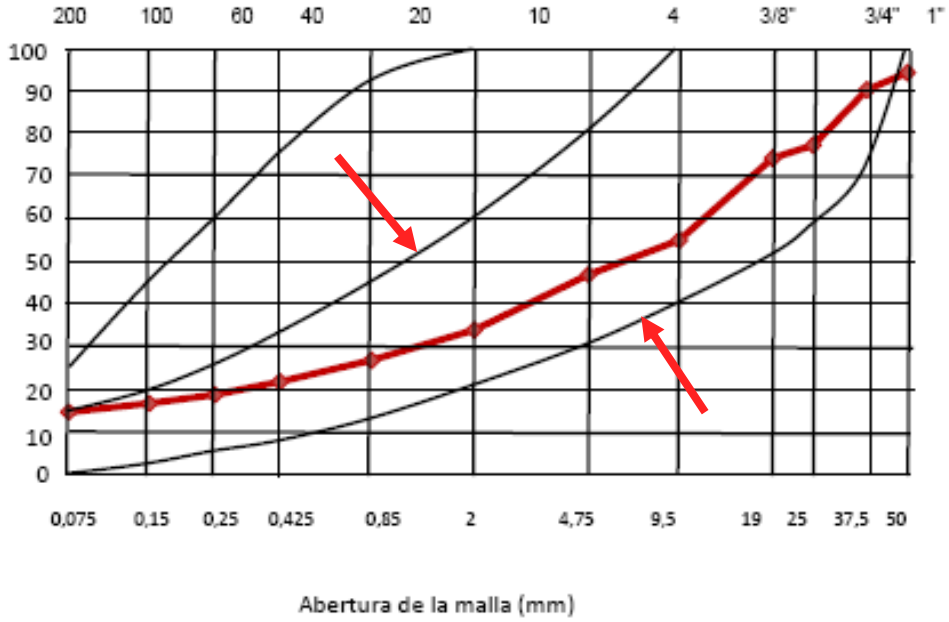
Hatch Mott MacDonald

Natural Sascab on Site

Sascab “Fill” Quarry Face

Typical Sascab Engineering Properties

	MALLA	RETENIDO
	EN 50.0	--
	EN 37.5	--
COMPOSICION GRANULOMETRICA		% QUE PASA
	2" (50.8)	95
	1 ½" (38.1)	91
	1" (25.4)	78
	3/4" (19.0)	75
	3/8" (9.51)	56
	No. 4 (4.76)	48
	No. 10 (2.00)	35
	No. 20 (0.841)	28
	No. 40 (0.425)	23
	No. 60 (0.250)	20
	No. 100 (0.149)	18
	No. 200 (0.074)	16
%DE DESPERDICIO DE LA MUESTRA		0% MALLA 3"



PRUEBA EN MAT. MAYOR QUE LA MALLA No. 3/8		ESPECIFICACIONES ASUR	OBSERVACIONES
ABSORCION %		NO APLICA	NO APLICA
MASA ESPECIFICA (DENSIDAD)		NO APLICA	NO APLICA
V.R.S. (ESTANDAR) %	158,0%	MINIMO 35 %	SI CUMPLE
EXPANSION %		NO APLICA	NO APLICA
EQUIVALENTE DE ARENA %		NO APLICA	NO APLICA

LAB CBR

Hatch Mott MacDonald

Field CBR – Truck gets elevated!

“Rockfill” Breakdown and Compaction

Hatch Mott MacDonald

Runway Embankment Completion

Hatch Mott MacDonald

New Runway/Taxiway April/2008 →

Hatch Mott MacDonald

Taxiway F/Links to T3 Apron

Infiltration Wells

Hatch Mott MacDonald

Runway/Rapid-Exit/Taxiway F

North Bridge Abutment and Taxiway F

Runway 30R Approach – July 2008

CTB Construction

Hatch Mott MacDonald

Crossover Taxiway and Bridge

Hatch Mott MacDonald

Existing/New Rwy and New ATCT

Hatch Mott MacDonald

Runway Open – October 20, 2009 →

Hatch Mott MacDonald

Cancún 2015

Hatch Mott MacDonald

Thank You!